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TOXICITY OF BITTERWEED* FOR SHEEP

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(**Actinea odorata*)

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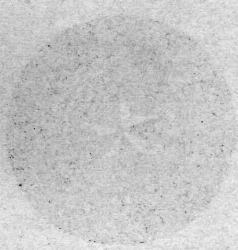
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Previous feeding tests and field observations* have established the toxicity of bitterweed (*Actinea odorata*) for sheep. The experiments reported herein prove that the minimum lethal dose of the fresh green bitterweed for healthy sheep, both during a normal year and during a drouth year, demonstrate the toxicity of the weed for sheep on fattening, maintenance, and less-than-maintenance rations. The poisoning is shown to be cumulative in type.

Feeding tests conducted with healthy yearling sheep showed that the minimum lethal dose of fresh green bitterweed growing during a year of normal rainfall and range vegetation was approximately 1.3 per cent of the body weight of the animal. A similar test in which healthy sheep were fed fresh green bitterweed growing during the drouth year of 1934 showed that the minimum lethal dose was approximately .5 per cent of the body weight. Feeding experiments of fresh green bitterweed at different stages of growth showed that there is a slight increase in toxicity as the weed matures.

Feeding tests conducted with healthy sheep which were eating a fattening ration and known to be gaining weight at the beginning of the test demonstrated that such animals were susceptible to bitterweed poisoning and that their state of nutrition had no appreciable effect on their susceptibility or resistance to the poisoning. Similar tests conducted on sheep receiving a less-than-maintenance ration and known to be losing weight likewise showed that the state of nutrition had no appreciable effect on the animal's susceptibility to the poisoning.

Daily feeding of fractional amounts of the established minimum lethal dose of the fresh green bitterweed over varying periods of time to sheep on a maintenance ration demonstrated that there is a definite correlation between the amount of weed fed and the time of appearance of symptoms of poisoning.

*Cf. Texas Agricultural Experiment Station Bulletin No. 433.

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TOXICITY OF BITTERWEED (*ACTINEA ODORATA*) FOR SHEEP*

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Feeding tests have shown that the minimum lethal dose of fresh green seedling bitterweed (*Actinea odorata*) for healthy sheep is approximately 1.3 per cent of the body weight. Experimental feeding of the seedling weed during the drouth year of 1934 showed very definitely that such drouth-grown weed is much more toxic than the weed growing during a normal year (21-24 inches rainfall). Other feeding tests have demonstrated the toxicity of bitterweed for sheep on less-than-maintenance, maintenance, and fattening rations when the animals were fed measured quantities of the weed daily for various periods of time.

Previous work at this Station and elsewhere had demonstrated the toxicity of bitterweed, and, since the weed was becoming more widely distributed every year, these studies were undertaken to ascertain definitely the amount of weed required to kill sheep and the effect of the state of nutrition of the animals on their susceptibility to poisoning, and to determine whether or not the poisoning was cumulative in type.

Review of Literature

The experimental work of Hardy, Cory, Schmidt and Dameron (1) showed conclusively that bitterweed is poisonous for sheep. They found that forced feeding of the weed was the only way by which consistent results could be obtained, since experimental sheep usually refused to eat bitterweed when it was placed in the feed box alone or mixed with palatable feed. Their report gives a botanical description of bitterweed, its distribution in Texas and other states, and describes the symptoms and the lesions in typical fatal cases. Finally these authors conclude that removing sheep from bitterweed areas is the only way in which poisoning can be controlled, and note that affected animals when penned and placed on feed usually recover but again become poisoned when returned to bitterweed infested range.

Clawson (2) demonstrated the toxicity of bitterweed through feeding tests, finding that consumption of 1.3 per cent of body weight of weed may result fatally, that daily consumption of .1 per cent of body weight of weed may induce illness in about 44 days, and that larger daily doses induce sickness in a correspondingly shorter time. He mentions the fact that bitterweed is evidently spreading over much of the range.

Jones, Hill, and Bond (3) reported on the work done to control the spread of bitterweed, concluding that this weed is unable to compete with perennial weeds and grass when there is a good turf in November and December, and that any system of control must include stocking the ranges in such a way as to give the

*The bulk of the experimental work reported in this bulletin was conducted during the years 1932-1934, and has been published in abstract form in the 45th, 46th and 48th Annual Reports of the Texas Agricultural Experiment Station.

grass and desirable weeds an opportunity to compete with and eventually choke out bitterweed. They found that a calcium chlorate spray, 12 pounds in 200 gallons of water per acre, is effective in killing bitterweed if the spraying be done during humid weather, preferably after a rain, and if all the plants are thoroughly covered. This solution does not damage either perennial plants or grass and is not toxic for sheep. Their report states that to pull the weed by hand and burn it helps to eradicate the weed when it is found along ditches and roads, and that insect damage to bitterweed seeds may play an important part in controlling the spread of the weed at certain times of the year. Finally they conclude that judicious stocking and resting of pastures accompanied by spraying of hazard areas such as lakebeds will eventually control the bitterweed if the program is followed conscientiously and persistently for a period of years.

Cory and Dameron (4) in their work on range control of bitterweed report that there was a 91 per cent reduction in bitterweed plants as judged by quadrat counts conducted over a period of six years when the grazing burden was reduced from 65 animal units to 50 animal units per section at Substation No. 14, Sonora, Texas.

Plan and Methods of the Experiments

The feeding tests reported herein were designed to ascertain: the toxicity of the weed at different stages of growth, the effect of the state of nutrition of sheep upon their susceptibility to bitterweed poisoning, and the cumulative effect of continued consumption of bitterweed.

In routine manner the seedling weed, one to two months old, was collected fresh, weighed, and usually stored overnight in the icebox. The next morning it was removed, weighed, passed through a meat grinder, and then force-fed by means of a balling gun. Water loss, occurring between the harvesting and feeding, was determined and allowed for in the dosage fed. In the tests establishing the minimum lethal dose of weed and determining the toxicity of the weed at different stages of growth, the whole dose was given at one time, accompanied by frequent swallows of water to prevent choking. It was found that healthy adult sheep could be given a considerable quantity of the freshly ground weed within approximately 45 minutes.

The animals used in these experiments were healthy, grade Rambouillet, mutton sheep weighing between 57 pounds and 85 pounds, except in two tests where older, heavier animals were used. All were brought in from the range, penned, and placed on a maintenance ration of cottonseed cake and alfalfa hay for from ten days to two weeks prior to the feeding tests. In all the tests the animals were held under observation before their release for at least ten days after weed feeding was finished, in case they did not succumb prior to this time.

Toxicity at Different Stages of Growth. In establishing the minimum lethal dose, which was essential before the rest of the projected tests could be made, the green seedling weed, about four inches high, was fed. The stems and flowers were ground up and fed, the roots being discarded before grinding.

In preliminary tests the dosage fed was arbitrarily placed at .75 per cent of the body weight. Two groups of five lambs each, averaging 60 pounds per head, were fed this quantity of freshly ground bitterweed. Aside from transitory bloat in a few of the animals they remained well and were released after an observation period of ten days.

In a further test two groups of five sheep each, of approximately equal weights, were fed 1.25 per cent their body weights of the freshly ground weed. All ten animals were off feed and sluggish the first 24 hours subsequent to feeding. Three died of acute bitterweed poisoning, two of them after 48 hours and one during the 92d hour. Two animals developed a chronic poisoning which persisted for sixteen days subsequent to feeding. The remaining five sheep, mildly sick and off feed to some extent for from three to seven days, were all normal when released 10 days after feeding.

Five healthy muttons, averaging 68 pounds in weight, were force-fed 1.37 per cent of their body weights of fresh bitterweed. All were sick three hours after feeding. Two of them died four hours later, two more were found dead approximately 15 hours later, and the fifth animal died some 27 hours later.

The results of feeding 1.3 per cent of the body weights of the fresh ground bitterweed to two groups of five sheep each are given in Table 1.

The water loss of the weed during storage was 9 per cent for the first group and 8 per cent for the second group. It will be noted that half of these animals died, while the other half recovered after showing clinical illness two or three days. Sheep 68 and 82 died 48 hours after feeding, while Sheep 79, 80, and 81 died approximately 30 hours after feeding. Autopsies of the dead animals revealed the typical lesions of acute bitterweed poisoning.

The fact that half of the animals in this test died from acute poisoning and that the remaining half of them were sick but recovered clearly indicates that the amount of weed fed, 1.3 per cent of the body weight, constituted the approximate minimum lethal dose of the fresh green weed. The fact that less than half of the animals fed slightly less, 1.25 per cent of body weight, died and that all the animals fed slightly more, 1.37 per cent of body weight, died of acute poisoning within 30 hours after feeding is definite evidence that the figure half way between these two amounts approached very closely the minimum lethal dose.

Feeding tests of bitterweed at various stages of growth are charted in Table 2. The established minimum lethal dose of 1.3 per cent body weight of green weed was fed to each group of animals except those consuming the six-months-old weed. These animals received only 1.25 per cent body weight. These tests were made during the spring of 1932, a normal year as regards rainfall and range vegetation.

It will be noted that all animals in each group of five died of acute poisoning. While the table does not show it, symptoms appeared progressively sooner as the more mature weed was fed. In other words there was evidence that the three months weed was slightly less toxic than the four months weed and that the four months weed was less toxic than the five months weed. The six-months weed was very definitely more toxic inasmuch as all five animals died within 24 hours after feeding; in fact, three of them were found dead early the next morning, approximately 18 hours after feeding and the other two died in 21 and 23 hours respectively. In the group fed the seven-months weed all five animals were dead next morning, approximately 20 hours after feeding. In this connection, it is worth mentioning that one group of five sheep, fed 1 per cent body weight of the seven-months weed remained healthy, none of them showing any symptoms of poisoning during a ten-day observation period. This result would indicate that the increase in the toxicity of the maturing plant is not very great in normal years.

Table 1. Minimum lethal dose of green seedling bitterweed for sheep

Sheep No.	Weight	Amount Fed*	Condition of Animals After Feeding					Results
			1st	2nd	3rd	4th	5th - 10th	
	Pounds	grams	day	day	day	day	day	
64	68	364	Off feed	Eating a little	Normal	Normal	Normal	Benign poisoning
65	61	327	Off feed	Eating a little	Normal	Normal	Normal	Benign poisoning
66	68	364	Off feed	Eating a little	Normal	Normal	Normal	Benign poisoning
67	65	348	Off feed	Eating a little	Normal	Normal	Normal	Benign poisoning
68	72	386	Off feed	Dead 8 a.m.				Acute fatal poisoning
79	51	276	Died 8:30 a.m.					Acute fatal poisoning
80	58	314	Died 6 p.m.					Acute fatal poisoning
81	71	383	Died 7 p.m.					Acute fatal poisoning
82	66	358	Off feed; sick	Dead 8 a.m.				Acute fatal poisoning
83	61	330	Off feed; sick	Eating a little	Normal	Normal	Normal	Benign poisoning

*Water loss of 9 per cent in weed fed Nos. 64-68 and 8 per cent water loss in weed fed Nos. 79-83. This loss was allowed for in computing amounts of weed fed.

Table 2. Toxicity for sheep of bitterweed at different stages of growth

No. Animals	Average Weight	Stage of Growth	Amount Fed on Basis Green Weed	Average Amount Weed Fed	Result	
					No. Died	Time Death Occurred After Feeding
	pounds	months	Percent body weight	grams		hours
5	72.2	3	1.3	396	5	24
5	51.8	4 flowering	1.3	259	5	24-48
5	67.8	5 flowering	1.3	355	5	24-48
5	98.7	6 seeding	1.25	464	5	18-24
5	64.6	7 seeding	1.3	380	5	20

During the drouth in December, 1934, a feeding test similar to that described above showed that the approximate minimum lethal dose of two-months-old weed was .5 per cent of the body weight. Three mature healthy sheep fed this amount died in 35, 27, and 45 hours respectively. This result amply indicates the increased toxicity of the drouth-grown weed. In the feeding tests conducted during the winter of 1934-1935 the above amount of weed, .5 per cent body weight, was used as the minimum lethal dose.

As a matter of fact the variation in the toxicity of the plant, as demonstrated in minimum lethal dose tests of seedling bitterweed one and two months old that grew during a year of normal rainfall or during a period of extreme drouth, raises the question as to whether it is possible to state authoritatively that weed at a certain stage of growth is always more toxic than younger weed. This question, of course, has no practical importance so far as the ranchman is concerned inasmuch as all tests have definitely shown that the weed is poisonous at all stages of growth

Effect of State of Nutrition of Sheep on Susceptibility to Bitterweed Poisoning. Since the field observations were not at all conclusive as to the effect of the nutritional condition of the animal on its susceptibility to bitterweed poisoning, it was thought advisable to settle the question definitely by feeding experiments. Accordingly ten yearling muttons were brought in from the range and placed on a maintenance ration of alfalfa hay and cottonseed cake for about ten days, after which they were divided into two groups of five each and placed on different rations.

The first group received daily 6 pounds of alfalfa hay, .25 pounds of cottonseed cake and 4 pounds crushed oats per head, a ration showing a nutritive ratio of 1:4.7 according to the Wolff-Lehmann Feeding Standard for yearling sheep. These animals were weighed when placed on this ration and again at the end of one and two weeks respectively. The final weights showed that the animals had gained an average of 5.3 pounds per head.

Table 3. Toxicity of bitterweed for sheep on fattening ration

Sheep No.	Initial Weight	Weight at Start of Test	Daily Dosage Green Weed	Daily Dose	Days of Test					Total Amount Weed Fed
					1st	2d	3d	4th	5th	
	pounds	pounds	per cent body weight	grams						per cent body weight
385	68	76	.26	90	Fed	Fed	Fed	Fed—Sick	Died	1.04
386	71	75	.26	88	Fed	Fed	Fed	Fed—Sick	Died	1.03
387	74	78	.26	92	Fed	Fed	Fed	Died		.78
388	61	66.5	.26	78	Fed	Fed	Fed	Died		.77
389	65	70	.26	82	Fed	Fed	Fed	Sick	Sick. Died next day	1.03

Table 4. Toxicity of bitterweed for sheep on a less-than-maintenance ration

Sheep No.	Weight		Weed Fed Daily		Days Fed	Total Amount Weed Fed	Result	
	Initial	Start of Test		grams			Day Sick	Day Died
	pounds	pounds	per cent body weight	grams		per cent body weight		
390	89	84	1/5 of .5	38	10	.998	11th	12th
391	75	72	1/5 of .5	33	18	1.79	19th	22nd
392	85	80	1/5 of .5	36	9	.9	10th	10th
393	78	78	1/5 of .5	35	9	.9	9th	10th
394	78	74	1/5 of .5	34	27	2.16	19th	31st

The next day the feeding of the fresh seedling bitterweed one to two months old at the rate of .26 per cent body weight (approximately .5 MLD) daily was started and continued until the animals showed definite symptoms of poisoning and refused feed. This test was conducted in 1934 when the minimum lethal dose of the weed was found to be approximately .5 per cent of the body weight.

The results of this test as given in Table 3 show that two sheep, 387 and 388, were dead of acute poisoning the morning of the fourth day, having received .78 per cent and .77 per cent body weight of weed respectively. Two others, 385 and 386, died on the fifth day having consumed a total of 1.04 per cent and 1.03 per cent respectively of their body weights of weed. The fifth sheep, 389, was very sick on the morning of the fourth day, became recumbent late in the afternoon, and was found dead on the morning of the sixth day, having received 1.03 per cent of body weight of the weed. Sheep 385, 386 and 389, received four daily doses of the weed, while sheep 387 and 388 received only three daily doses. None of the animals ate well on the third day of the test, and the three sheep surviving on the fourth day were visibly sick and completely off feed.

The second group was placed on a ration of alfalfa hay and cottonseed cake insufficient in amount to maintain their body weights. Since these animals had been consuming a growing ration for two weeks prior to being placed on the less-than-maintenance ration, they were weighed at weekly intervals, and on the 24th day all were found to be losing weight, although two of them were still above the weight registered when placed on the less-than-maintenance ration.

They were force-fed fresh seedling bitterweed one to two months old at the rate of .2 minimum lethal dose (.5 per cent body weight) daily until symptoms of poisoning appeared and they refused their regular ration. The results of this experiment are shown in Table 4.

It will be noted that two sheep, 392 and 393, died on the tenth day after weed feeding was started, both animals having shown symptoms 24 hours prior to death. Each consumed, .9 per cent of its body weight of the weed. Sheep 390 received the last weed on the 10th day, was typically sick on the 11th day, and found dead the next morning, having consumed .998 per cent of body weight of weed. Sheep 391 consumed 1.79 per cent body weight of weed in 18 consecutive days, was off feed and sick on the 19th day, became progressively worse and died on the 22nd day after the test started. The last animal, 394, showed typical symptoms on the 19th day, refused feed and did not consume any weed for the next three days. Weed feeding, resumed on the 22nd day when the animal was convalescent and showing a good appetite, was continued daily through the 30th day. This animal, which had become progressively weaker during the last five days of weed feeding, was found dead on the morning of the 31st day of the test. It consumed a total of 2.16 per cent body weight of weed in 30 consecutive days in 27 separate feedings.

Cumulative Effect of Continued Consumption of Bitterweed. Field evidence indicated that the poisoning was cumulative in type and resulted, on the range, from continued grazing of the weed over a period of days, rather than consumption of a toxic quantity in a day's time. Accordingly feeding tests were conducted in which fractional doses of the established minimum lethal dose of the green weed were given daily to healthy sheep eating a maintenance ration of cottonseed cake and alfalfa hay.

Table 5. Sheep on maintenance rations fed varying amounts of MLD of bitterweed daily

Group	No. of Animals	Average Weight	Average—Weed Fed Daily		Average Time Fed	Average Amount Fed	Average MLD Fed	Average Time First Sickness appeared	Average Time Death occurred	Recovered
			per cent body weight	grams						
		pounds			days	per cent body weight		day	day	day
A	5	102.2	1/3 of 1.3	201	12.6	5.4	4.2	6.5th	13.4th	
B	5	75.2	1/6 of 1.3	74	25.4	5.5	4.2	20th	27th	
C	5	73.2	1/12 of 1.3	40	37.6	4.07	3.13	34.4th	42nd	
D	5	69.2	1/24 of 1.3	17	100.4	5.4	4.18	62nd	Four sheep on 92.75th	One sheep on 134th
E	4	56.2	1/48 of 1.3	7	132.25	3.5	2.7	97.8th	One sheep on 124th	Three sheep on 135th

Twenty-five healthy, grade Rambouillet sheep, either adults or short yearlings, were penned in the barn and fed a maintenance ration of alfalfa hay and cottonseed cake. The animals were fed in this way for about ten days when weighing indicated that they were just about maintaining their weights. At this time they were divided into five groups of five animals each, of approximate ages and weights, and, in addition to the regular ration, were given daily doses of bitterweed as follows:

Group A —	1/3	Minimum lethal dose		
Group B —	1/6	"	"	"
Group C —	1/12	"	"	"
Group D —	1/24	"	"	"
Group E —	1/48	"	"	"

These tests were conducted during the spring of 1933 when the minimum lethal dose of the seedling bitterweed was approximately 1.3 per cent body weight.

These tests are summarized in Table 5. They show that the sheep became sick and later succumbed to the poisoning when the animals in each group had received approximately the same amount of weed. It will be observed that the animals in Group A, for example, showed symptoms on the 6th day and succumbed on the 13th day, while those in Group B showed first symptoms on the 20th day and died on the 27th day. But in both these groups we find that the total percent of body weight of weed consumed is just about the same. The same relative parallel is found in the other three groups except that one animal recovered in Group D and three animals recovered in Group E, where the one fatal case consumed only 2.7 minimum lethal doses, a figure apparently lower than in the other groups. In both these groups, however, all of the animals showed symptoms of poisoning when they had consumed amounts of weed approximately equal to those eaten by fatally poisoned animals in the other groups. All four recovered animals in these groups consumed the daily dose of weed subsequent to recovery from the initial manifestation of symptoms but lost weight and condition, being in very poor shape when released. Evidently the poison has a cumulative effect which is clinically manifested but not necessarily fatal if the weed fed daily be restricted to a sufficiently small amount. In the case of the recovered animals the tests were discontinued principally because no weed was available for further feeding. One of the animals in Group C that died of an intercurrent disease on the 63rd day is not shown in this table.

One sheep each in Groups A and C showed a subsidence of symptoms about five days after the first sign of poisoning; however, typical symptoms reappeared which terminated in death on the 10th and 2nd day respectively. In Group D the one recovered animal was really a sufferer from chronic poisoning inasmuch as this animal never regained its original condition during the ten months succeeding its release from the test.

DISCUSSION

The feeding tests to establish the minimum lethal dose of green seedling bitterweed showed that this could be determined with approximate accuracy. Further, a similar test with weed growing during the drouth year of 1934 showed very definitely that there is an increase in the toxicity of such drouth-grown weed. This probably accounts for the fact that during the drouth years the losses on the range

may be much heavier than during years of normal rainfall and average range vegetation. The animals manifest and succumb to the poisoning after consuming appreciably smaller quantities of the weed.

Feeding tests of bitterweed at different stages of growth indicated that there is some increase in toxicity as the weed matures even though such increase is not always demonstrable in experimental feeding tests. Animals fed .05 per cent body weight less than the established minimum lethal dose of the six-months-old weed succumbed to acute poisoning, while those fed .3 per cent of the body weight less than the minimum lethal dose, of the seven months weed did not manifest any symptoms (Page 7). Another group of five sheep died from acute poisoning when fed the full minimum lethal dose (1.3 per cent body weight) of seven months weed. These results, which are shown in Table 2, indicate a small but definite increase in toxicity in the maturing weed.

The results of the tests conducted with sheep on fattening and on less-than-maintenance rations showed that the state of nutrition is apparently not of paramount importance to the animal's susceptibility to bitterweed poisoning. The animals on the fattening ration died sooner than the animals in the less-than-maintenance group, but Tables 3 and 4 show that the two groups consumed about the same amount of weed. The difference in the rate of death is more apparent than real since the animals on the fattening ration received proportionately larger daily doses of weed than did the animals in the other group.

The tests in which the animals on maintenance rations were fed varying quantities of the minimum lethal dose of bitterweed daily showed very definitely that the poisoning is cumulative in character and that such poisoning results in sickness and death or in chronicity when the animals have consumed a sufficient amount of weed. This holds true whether the daily dose be relatively large or relatively small. In all but one case (sheep dead from poisoning in Group E, Table 5) the amount of weed required to produce poisoning was approximately the same, even though fed over greatly varying periods of time.

The practical conclusions to be drawn from the tests recorded in this bulletin are that bitterweed is toxic for sheep in all stages of growth and that the animals will succumb to the poisoning if they eat a sufficient quantity. Obviously the losses will be greatest when the palatable range vegetation is scarce or absent and the bitterweed is abundant and tempting. And these conclusions hold true regardless of the stage of nutrition of the range sheep.

SUMMARY

1. The feeding tests of the fresh green seedling bitterweed, growing during a normal year, demonstrated that the minimum lethal dose for healthy sheep is approximately 1.3 per cent of the body weight of the animal when fed as a single dose. A feeding test of similar weed, grown during the drouth year of 1934, showed that the minimum lethal dose under such conditions is much lower, approaching .5 per cent of the animal's body weight.

2. Feeding tests with bitterweed of different ages, three to seven months, indicate that there is some increase in toxicity as the weed matures. Since there is considerable variation in the susceptibility of different sheep to the weed, however, it is difficult to measure such increase.

3. The state of nutrition in healthy yearling sheep apparently has little, if any, effect on the animal's susceptibility to bitterweed poisoning. Animals on both

fattening and on less-than-maintenance rations succumbed to poisoning after ingesting about the same amounts of the weed.

4. The poisoning resulting from eating bitterweed is cumulative in type. There is a definite correlation between the amount of weed eaten and the time of the appearance of symptoms.

LITERATURE CITED

1. Hardy, W. T., Cory, V. L., Schmidt, H., and Dameron, W. H. 1931. Tex. Agr. Exp. Station, Bul. 433.
2. Clawson, A. B. 1931. A Preliminary Report on the Poisonous Effects of Bitter Rubber Weed. (*Actinea odorata*) on Sheep. Journ. of Agr. Res., Vol. 43, No. 8, pp. 693-701.
3. Jones, S. E., Hill, W. H., and Bond, T. A. 1932. Tex. Agr. Exp. Station, Bul. 464.
4. Cory, V. L., and Dameron, W. H., 1937. Range Studies of Bitterweed. Southwestern Sheep and Goat Raiser, Vol. 7, No. 11, pp. 8-9.